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THE WEATHER AND CIRCULATION OF SEPTEMBER 1969

Persistence of the August Regime in the United States

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1. MEAN CIRCULATION

The mean trough-ridge pattern over the United States was very similar to that of August, but elsewhere in the middle and high latitudes of the Northern Hemisphere fairly large changes occurred. The strong upper level ridge extending over the Arctic Basin from North America (fig. 1) replaced a deep Low that had persisted over the Beaufort Sea most of the summer. The 700-mb surface rose 160 m in that area (fig. 2). East of this strong ridge, a long fetch of brisk northwesterly flow over eastern Canada resulted in a deep complex Low over the Greenland area with two major negative anomaly centers (fig. 3). The 80-m center between Greenland and Scandinavia represented a drop of 180 m in the 700-mb height from the previous month for that locality.

In the Pacific area, the formation of a Low over the Bering Sea during September with an intense trough extending into the Gulf of Alaska caused increased westerlies in the middle latitudes which reversed a long period retrogression of the Pacific ridge (Dickson, 1969). Downstream changes in the monthly mean pattern resulting from these increased Pacific westerlies were minor; however, weekly changes across the United States were quite striking. These changes will be discussed in detail under section 4.

Progression at the higher latitudes across Eurasia was predominant in September with August's trough near Novaya Zemlya moving to eastern Asia and being replaced by a ridge that moved eastward from Scandinavia. In the European area, the formation of a new monthly mean trough over Spain was associated with rising 700-mb heights over central Europe as the cutoff Low over Europe during August rejoined the westerlies to form a full latitude trough from east of the Black Sea to the Arctic Basin.

2. TEMPERATURE

The temperature anomalies over the United States, like the 700-mb heights, changed very little from August. Above-normal temperatures prevailed over most of the western part of the Nation (fig. 4). A strip of near- to above-normal temperature extended eastward along the northern border to New England. The axis of the largest positive temperature anomalies extending from California across Nevada, northern Utah, and through Wyoming was associated with the most extensive area of below-normal rainfall. Bakersfield, Calif., Salt Lake City (Airport), Utah, and Lander, Wyo., reported the warmest September of record, while Casper, Wyo., reported its highest average maximum temperature.

Below-normal temperatures were observed from the Ohio Valley and the Middle Atlantic States southward, except in southern Florida. The low temperatures were partly the result of cloudiness and precipitation associated with light easterly anomalous flow at the 700-mb level and easterly surface winds (fig. 5). However, there were incursions of cool air from the north that contributed to the low temperatures. These cool air masses were deployed southward by the large North American ridge extending into the Arctic Basin (fig. 1).

3. PRECIPITATION

The distribution of rainfall during September (fig. 6) was also similar to the August pattern—the most apparent difference being a reduction of the anomalously light rainfall area in the Far West and Northern Plains that was present in August. Although reduced in extent, the persistent dryness in the same region where the warmest temperatures occurred continued forest fire hazards. Sheridan, Wyo., reported the driest September of record and extended a dry spell that began in July; the total July through September rainfall of 0.80 in. was also a record low amount at Sheridan. Lander, Wyo., with 0.01 in. of rain tied the previous low record for the month since 1891. Valentine, Nebr., has had the driest January through September period of record this year.

Much of the heavier rainfall near the Atlantic seaboard was associated with tropical disturbances, while heavy rainfall in the Ohio Valley, the upper Mississippi Valley, and North Dakota was mainly frontal precipitation; whereas, above-normal rainfall in much of the Southwest was related to upslope motion by southeasterly surface flow (fig. 5) that was somewhat stronger than normal (fig. 7). The heavy rain in the Northwest was also associated with lifting over rising terrain by the stronger than normal westerlies. Seattle and Olympia, Wash., with monthly totals of 5.41 in. and 5.23 in., respectively, reported the largest September rainfall of record.

4. INTRAMONTHLY VARIATIONS

Comparing September mean weather and circulation features to those of August showed little month-to-month change in the United States. Yet, figures 8 through 11 illustrate that the increased westerly flow across the Pacific caused a continual motion of long-wave trough and ridges across the United States. The 700-mb height anomaly reversed sign every week of the month in the East with a similar but opposite change occurring over much of the West. The temperature and rainfall patterns did not have large-scale reverses in their anomalies, but

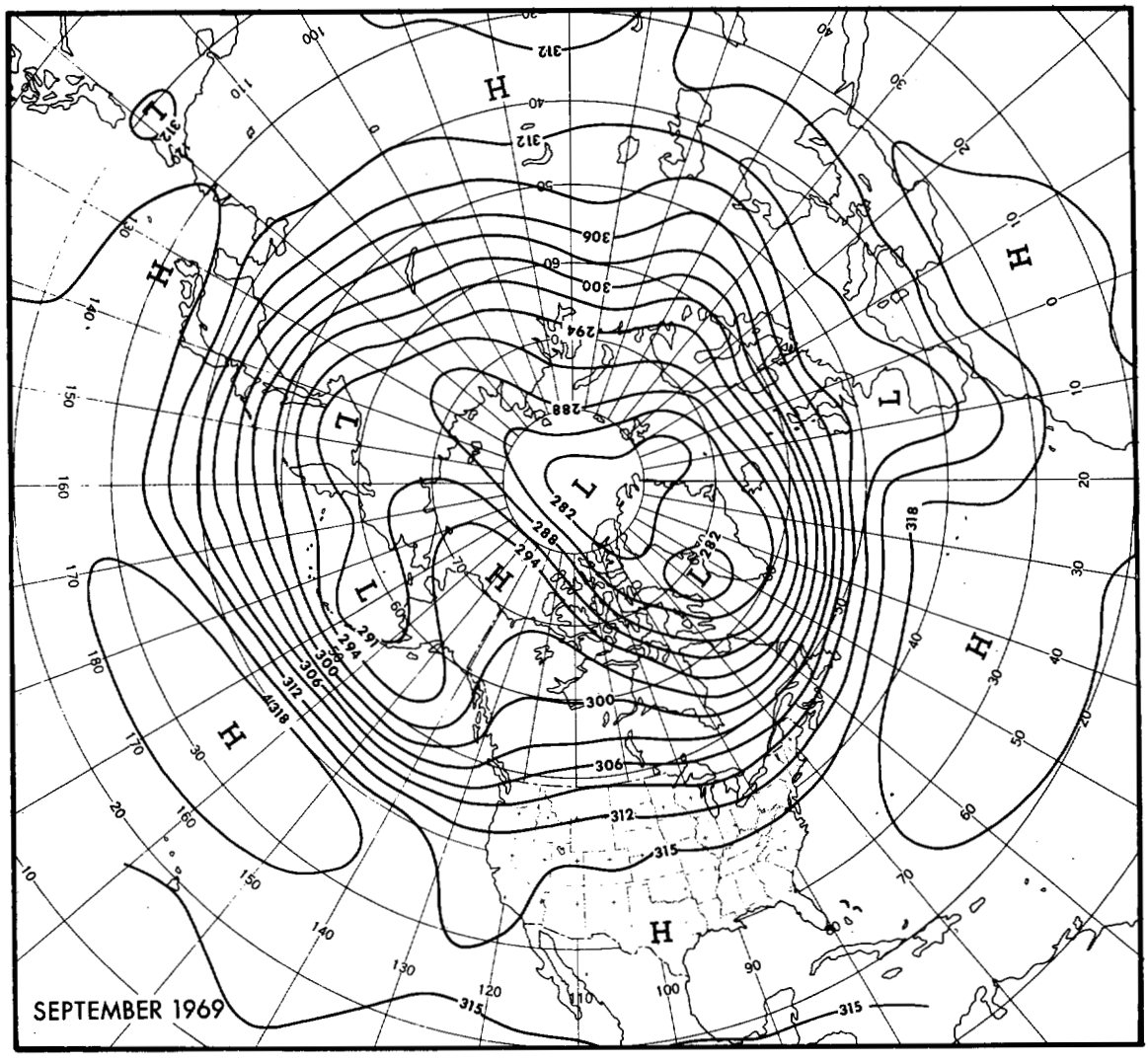

FIGURE 1.—Mean 700-mb contours (in decameters) for September 1969.

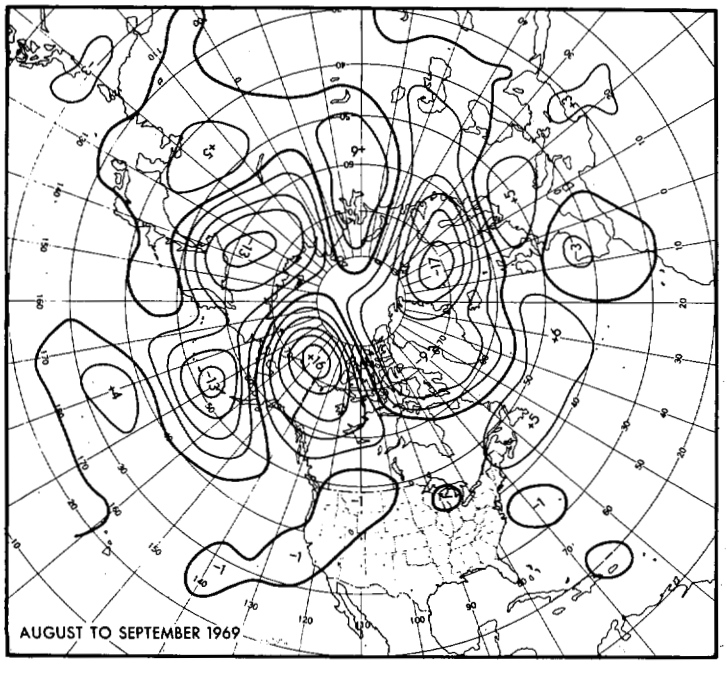

FIGURE 2.—Mean 700-mb height anomaly change (in decameters) from August to September 1969.

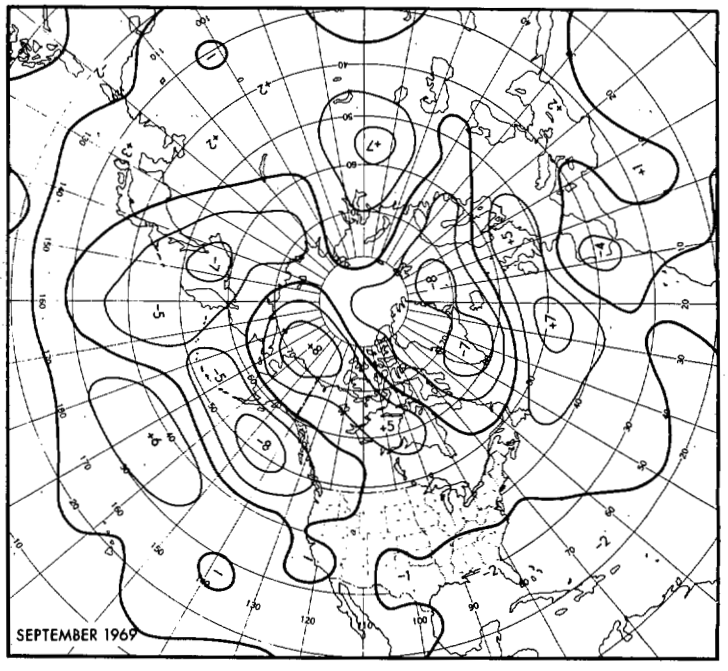

FIGURE 3.—Departure from the normal of the mean 700-mb height (in decameters) for September 1969.

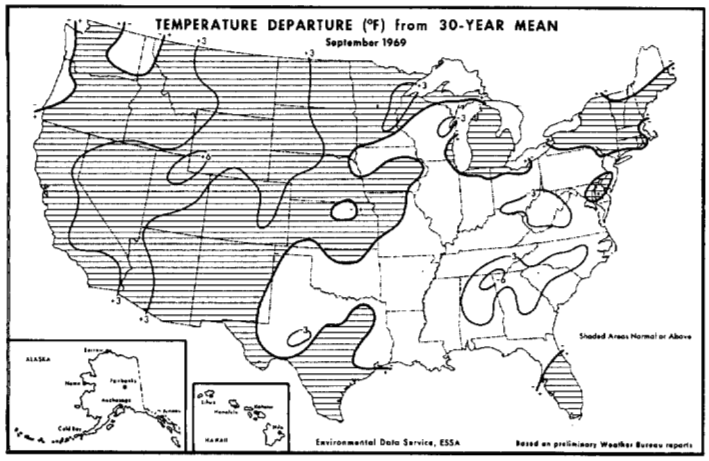

FIGURE 4.—Departure from normal of average surface temperature (°F) for September 1969 (source, Environmental Data Service, 1969).

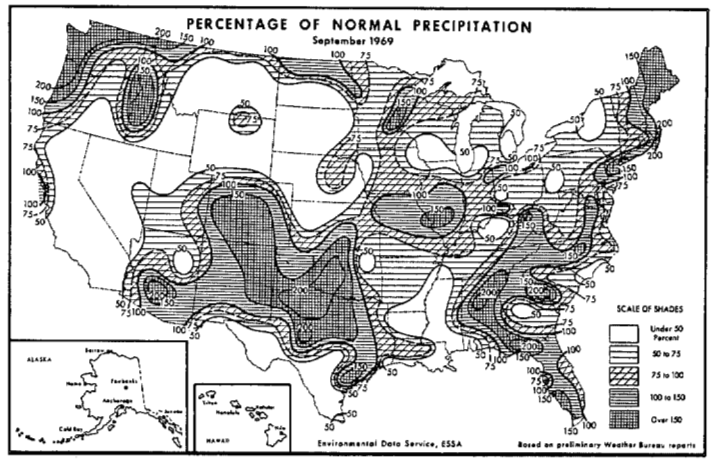

FIGURE 6.—Percentage of normal precipitation for September 1969 (source, Environmental Data Service, 1969).

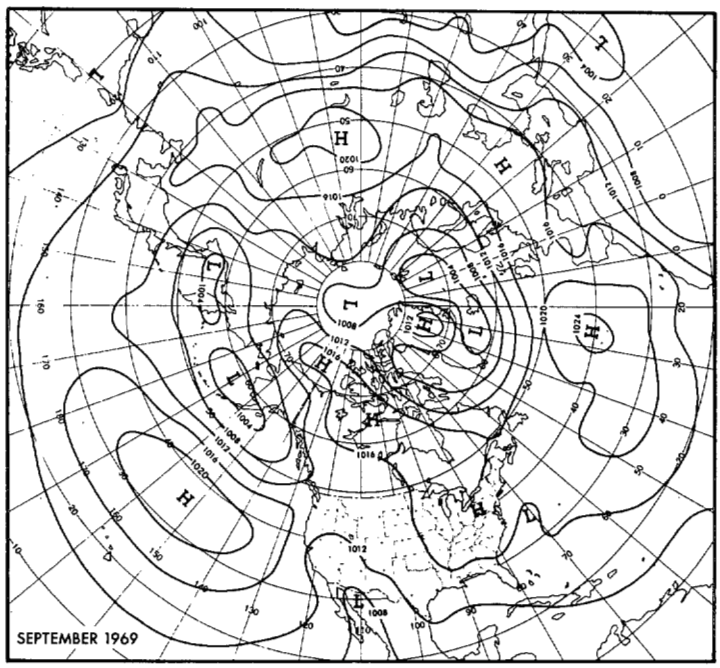

FIGURE 5.—Average sea-level pressure (in millibars) for September 1969.

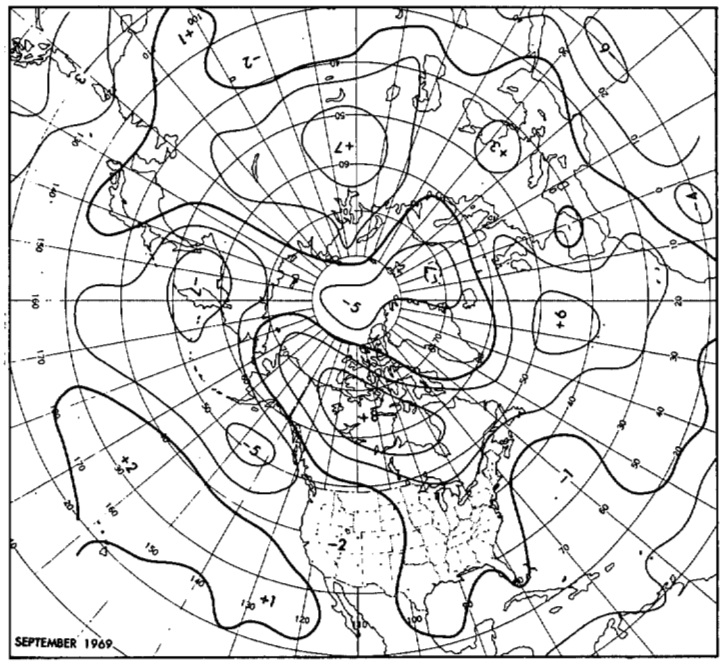

FIGURE 7.—Average sea-level pressure anomaly (in millibars) for September 1969.

changes were occurring in the weather patterns throughout the month.

South to southwesterly upper level flow associated with a strong High off the east coast (fig. 8A) gave the country a generally warm regime the first week of September (fig. 8C). The major exception was the Northwest where northwesterly 700-mb flow kept temperatures an average of about 3°F below normal. Southeasterly anomalous flow aloft (fig. 8B) resulted in widespread but chaotic patches of heavy precipitation in the East (fig. 8D), while generally westerly flow over the Rocky Mountains and northwesterly winds over the Northwest caused mostly dry conditions in the West.

As the mean Low in western Canada during the first part of the month moved eastward to join the Greenland trough the second week of September, a full latitude trough formed over the east coast of North America (fig. 9A), bringing rapid cooling and drying to most of the East (figs. 9C and D). Hurricane Gerda, which preceded the arrival of the cool air, made a significant contribution to the heavy precipitation in the Northeast during the second week. The 1- to 2-in. rainfall in and near Texas is best explained by upslope flow on the southwest side of the strong surface High that came south from Canada during the week. A strong upper level ridge and associated positive height anomaly were accompanied by widespread warmth in the West.

Continued progression of the long-wave pattern over the United States during the third week of the month brought a return of south to southwest flow aloft to most of the

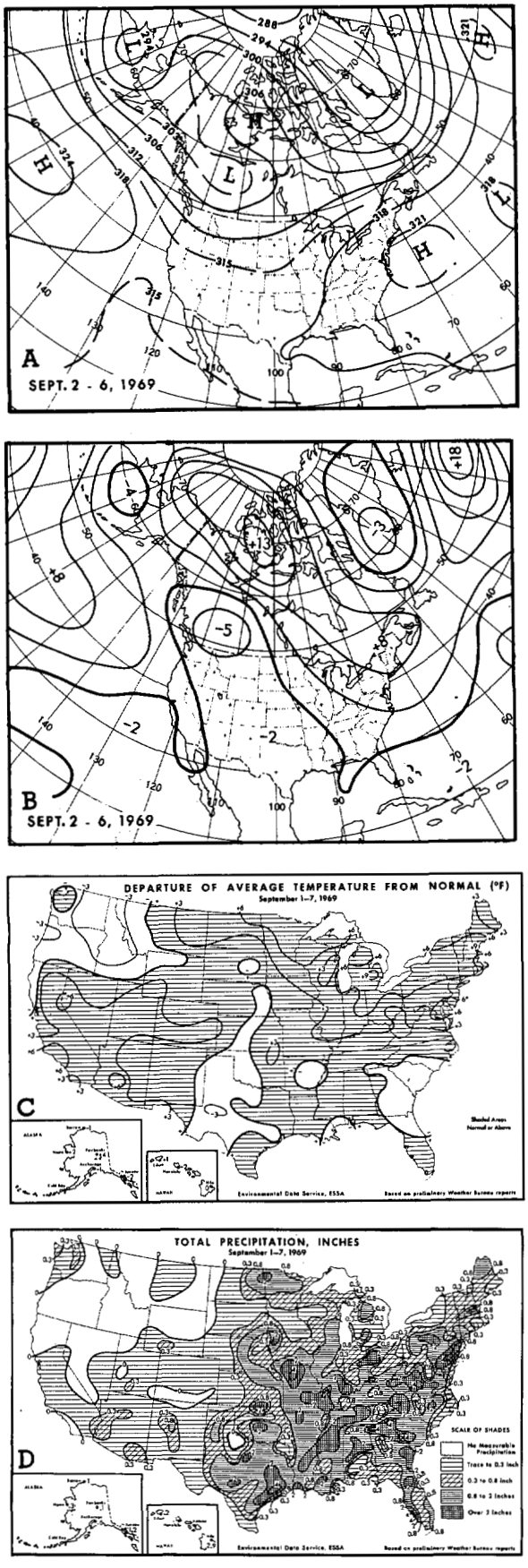

FIGURE 8.—(A) mean 700-mb contours and (B) departure from normal (both in decameters) for Sept. 2–6, 1969; (C) departure of average surface temperature from normal (°F) and (D) total precipitation (inches) for week of Sept. 1–7, 1969 (source, Environmental Data Service, 1969).

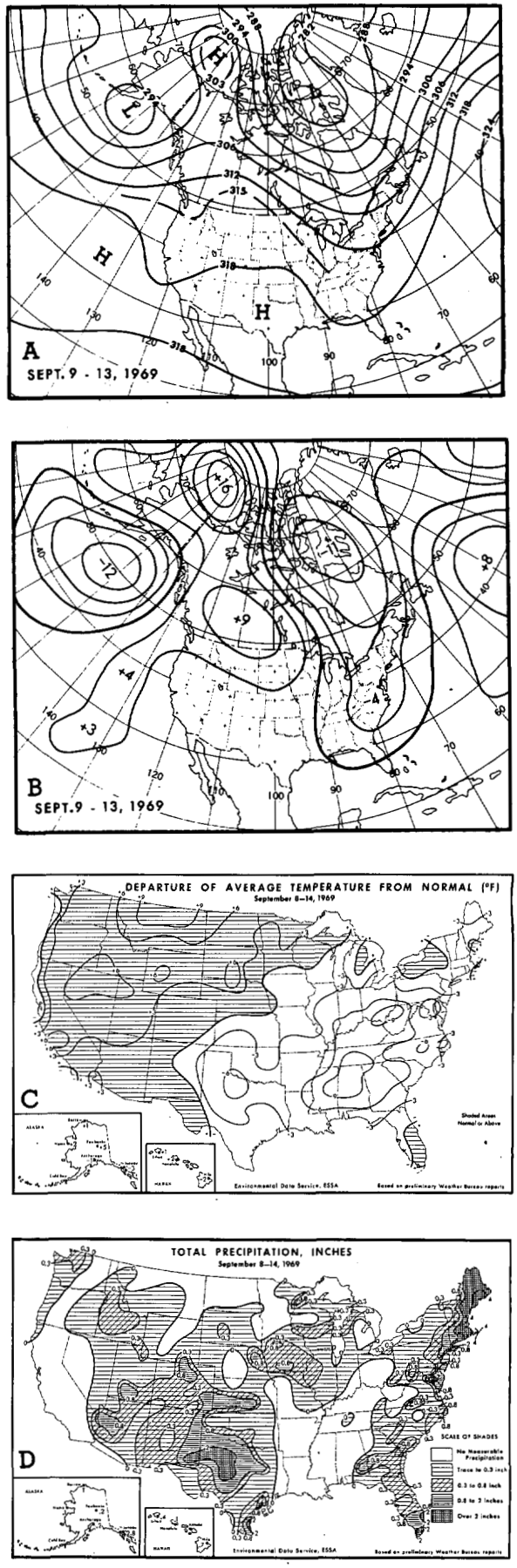

FIGURE 9.—Same as figure 8, (A) and (B) Sept. 9–13, 1969; (C) and (D) for week of Sept. 8–14, 1969 (source, Environmental Data Service, 1969).

country (fig. 10A). Some warming occurred in the East, but the strong high-latitude ridge over the Beaufort Sea forced another very strong surface High southward across New England, thus bringing a new outbreak of cool air that kept temperatures in much of the East below normal (fig. 10C). Southeasterly anomalous flow at the 700-mb level (fig. 10B) help produce unusually heavy rains along the advancing edge of the cool air from the Southern Plains into the Ohio Valley (fig. 10D). Most of the very heavy rain (up to 12 in.) in the Southeast was associated with a weak tropical disturbance that moved inland from the Gulf of Mexico. The advance and deepening of the Gulf of Alaska Low brought cooling to the Far West this week and heavy rain to the Northwest.

The west coast trough moved rapidly eastward to the Great Lakes (fig. 11A) the fourth week of September, again causing below-normal 700-mb heights (fig. 11B) and fresh cooling (fig. 11C) to the east. Areas in the Tennessee Valley that had warmed to above normal the previous week were again the center of some of the largest negative temperature anomalies, as they had been the second week of September, completing a 2-week cycle in the temperature in that region. The highly variable precipitation pattern in the East (fig. 11D) was similar to the first week of the month, but amounts were generally lower than early September rainfall. Return of an upper level ridge to the west was accompanied by warm weather in all of the West and the driest week of the month for that area.

5. TROPICAL STORMS

Stronger than normal surface easterlies (fig. 7) and easterly anomalous flow at the 700-mb level south of 40° over the Atlantic (fig. 3) spawned numerous tropical Lows this month. Four of these reached sufficient strength to be given names under the Weather Bureau classification system, and three reached hurricane intensity. Another hurricane, Francelia, was in the Caribbean west of Jamaica at the beginning of the month. This storm continued on a westward course into Central America on the 3d and lost its identity in the mountains of Honduras on the 4th.

Hurricane Gerda formed as a tropical depression in the western Bahamas during the 5th, and after a short journey through southern Florida reentered the Atlantic Ocean. Gerda's course paralleled the east coast northward as it increased to hurricane strength. Its path was far enough from the east coast so that no appreciable effect was observed along the coast until a landfall occurred in southeastern Maine on the 9th. With an injection of cold air, Gerda rapidly became extratropical as it moved inland; in fact, Gerda had considerable extratropical characteristics before reaching land.

Hurricane Holly formed about midmonth several hundred miles east of the Windward Islands. After increasing briefly to minimal hurricane force, this storm weakened to become an easterly wave north of Puerto Rico by the 21st.

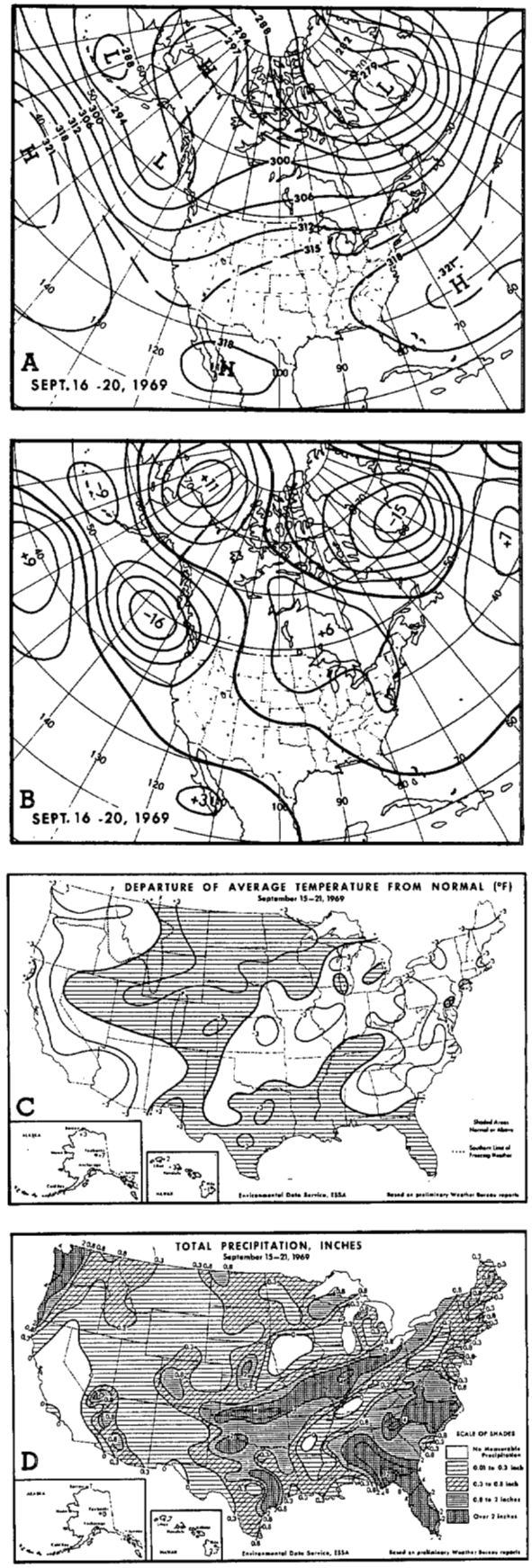

FIGURE 10.—Same as figure 8, (A) and (B) Sept. 16–20, 1969; (C) and (D) for week of Sept. 15–21, 1969 (source, Environmental Data Service, 1969).

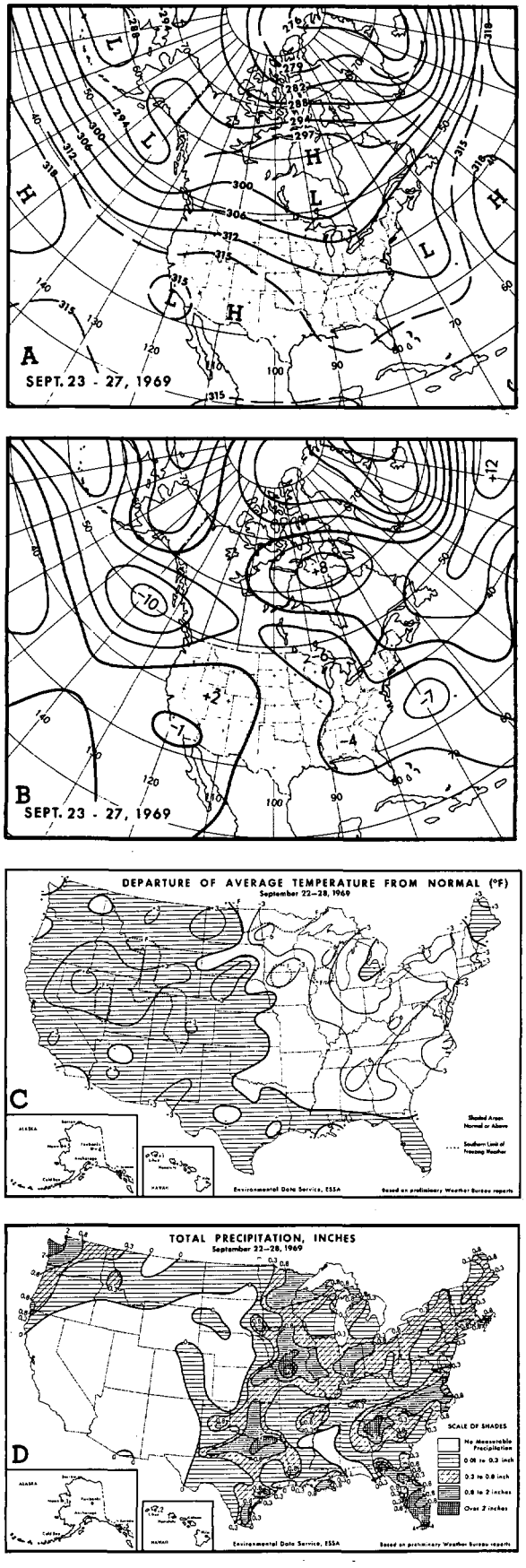

FIGURE 11.—Same as figure 8, (A) and (B) Sept. 23–27, 1969; (C) and (D) for week of Sept. 22–28, 1969 (source, Environmental Data Service, 1969)

The third hurricane to form this month, Inga, was located in the same general area as Holly at about the same time that Holly lost its identity. Inga increased to tropical storm intensity as it moved west to west-northwest until the 25th, then weakened as it turned more northward between 60° and 65° W. On the last day of the month, Inga curved northeastward and intensified to hurricane strength.

Tropical storm Jenny formed south of Cuba on the last day of the month and later moved northward into Florida. Jenny did not have winds that exceeded tropical storm force at any time.

Two other tropical Lows formed in the Gulf of Mexico during September. Neither of these gained sufficient wind speed to be classified as tropical storms, but both caused large amounts of rainfall in the Southeast. One of these depressions did not move inland until after the end of the month.

Four tropical storms appeared in the eastern Pacific during September. The first three dissipated during the month without reaching hurricane strength or having major effect upon land areas, although two of them passed close to the southern end of Baja California. The last of these four storms, Irah, was identified as a tropical storm on the last day of September.

The tropical waters of the western Pacific, usually one of the more active tropical storm areas at this time of the year, had very little activity during the first part of the month. Typhoon Doris began on the last day of August in the South China Sea and moved into Vietnam on the 3d. No other tropical storm was identified in the western Pacific north of the Equator until Elsie began on the 19th south of 20° and near 160° E. Elsie progressed steadily westward attaining typhoon strength and moved across northern Formosa before entering the Chinese mainland and dissipating on the 27th. Tropical storm Flossie formed east of the Philippines on the 29th of September and was moving northwestward still east of the islands at the end the month. The last of the western Pacific storms this month, Grace, was located on the 30th near 170° E. and 30° N. Grace reached typhoon classification by 0600 GMT on October 1.

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Dickson, R. R., "The Weather and Circulation of August 1969—A Month With Record Warmth in the West," *Monthly Weather Review*, Vol. 97, No. 11, Nov. **1969**, pp. 830–834.

Environmental Data Service, ESSA, *Weekly Weather and Crop Bulletin*, Vol. 56, Nos. 36–40, Sept. 8, 15, 22, 29, and Oct. 6, **1969**.